DOCUMENT RESUME

ED 098 082 SE 018 491

AUTHOR Phillips, Darrell G.
TITLE Research Related to the Work of Jean Piaget: A Critique. Technical Report No. 3.
INSTITUTION Iowa Univ., Iowa City. Science Education Center.
REPORT NO TR-3
PUB DATE Oct 74
NOTE 33p.

EDRS PRICE MF-$0.75 HC-$1.85 PLUS POSTAGE
DESCRIPTORS *Cognitive Development; Cognitive Measurement; *Educational Research; Logical Thinking; Research Design; Research Methodology; *Research Reviews (Publications); *Science Education
IDENTIFIERS *Piaget (Jean)

ABSTRACT

This publication consists of a critique of research related to the work of Piaget. Contents are arranged under five headings: Introduction, Common Misconceptions and Mususes, Common Research Errors: Possible Causes and Cures, Evaluation of Piaget-related Research, and Extension. Eighteen references conclude the report. (PEB)

Science Education Center, The University of Iowa, Iowa City, Iowa 52242

SCIENCE EDUCATION CENTER

The University of Iowa

October 1974

technical report 3

Research Related to the Work of Jean Piaget: A Critique

by

Darrell G. Phillips

The Technical Report Series

The Technical Report Series of the Science Education Center, University of Iowa, was established by action of the faculty during 1973. The series provides a mechanism for communicating results of research, developmental projects, and philosophical investigations to others in Science Education. The reports include details and supporting information not often included in publications in national journals.

Authors of technical reports include the faculty, advanced graduate students, alumni, and friends of science education at Iowa. Technical reports are distributed to all major Science Education Centers in the United States. Reports are also generally available upon request for the cost of packaging and mailing.

Major programs centered in Science Education at the University of Iowa include the following: Science Foundation, a core course in Liberal Arts for undergraduates in education; a special concentration in science for elementary education majors; an undergraduate and a graduate sequence in the history and philosophy of science; a general science major in Liberal Arts, including five emphases for secondary science teaching (biology, chemistry, earth science, environmental studies, and physics); Iowa-UPSTEP, a model six year sequence for preparing new science teachers at the secondary level; undergraduate and graduate programs in environmental studies; Project ASSIST, a statewide curriculum implementation program for in-service teachers; SSTP, a summer and academic year program series for highly interested and motivated secondary school students; self-instruction materials, including computer-based programs.

Major research thrusts at Iowa not reflected in the listing of special programs include: Piagetian Developmental Psychology, Kinetic Analysis of Verbal Discourse, Classroom Interaction Studies, Teacher Skills and Attitudinal Studies.

Information concerning the Technical Report Series can be received by contacting the Science Education Librarian, Room 470, Science Education Center, University of Iowa, Iowa City, Iowa 52242. Lists of dissertation and thesis reports are available. Also, Field Service Reports, Special Project ASSIST Reports, reports of faculty research, and material describing the various facets of the programs at Iowa are available from the same source.

Since the primary function of the Technical Report Series is communication, comments from you and other consumers of the series are solicited.

Robert E. Yager, Coordinator
Science Education Center
University of Iowa

Darrell G. Phillips
Associate Professor
Science Education Center
University of Iowa
Iowa City, Iowa 52242

RESEARCH RELATED TO THE WORK OF JEAN PIAGET: A CRITIQUE

Table of Contents

RESEARCH RELATED TO THE WORK OF JEAN PIAGET: A CRITIQUE

technical report 3

INTRODUCTION

The purpose of this paper is to initiate discussion concerning interpretations and techniques of performing and evaluating Piaget-related research. This paper is not intended to express a position in the argument of whether Piaget is "wrong" or "right," nor does this author classify a study as "good" if it agrees with his own biases. Examination of the research literature reveals that there are many poorly-performed studies, some of which refute and some of which support Piaget's findings. There are, of course, some excellent studies in the literature, but unfortunately these few studies are often obscured by the more numerous misguided attempts at research.

An increasing number of published articles indicates that more and more independent investigators are becoming involved with Piaget-related research. This proliferation of research effort within Piaget's theoretical framework should contribute to an improved understanding of human intellectural development, but such results have not been forthcoming. Theoretical misconceptions and poor research techniques have served to mask definitive contributions.

In brief, a large portion of the published, Piaget-related research is of extremely poor quality. These papers so frequently violate the fundamental tenets of objective investigation that the title of "research paper" is a misnomer.

A portion of this article was presented at the Piaget Conference, William James College, Allendale, Michigan, May, 1972.

For example, an opening paragraph often cues the reader as to the author's bias -- the paper is either going to "prove" or "disprove" Piaget's theory -- thereby allowing little leeway for objectivity. Even more serious is the omission of pertinent and necessary information. Many authors do not include equipment descriptions, task protocols* or scoring criteria in their articles; therefore, the reader cannot intelligently evaluate the study, and any attempt at replication is impossible.

A critique of research practices and the enumeration of certain misconceptions may seem to be an unnecessary expenditure of effort, but the errors contained in much of the literature are not insignificant: they are fundamental.

Common Misconceptions and Misuses

Informational Errors

Even though Piaget's work is becoming more widely known in this country, there are still those individuals who are under the impression that his research has been done with only a few children, his own children in particular. Such information is approximately thirty years out of date. Hundreds of subjects have been interviewed for research purposes since the early 1940's. Another common misconception is that Piaget's work applies only to young children. The Growth of Logical Thinking (Inhelder and Piaget, 1958) reports data from interviews with over 1500 subjects whose ages ranged from five-year old preschool children to sixteen-year-old adolescents.

*In this paper the term "task protocol" refers only to the investigator's script, i.e., all relevant statements and questions uttered by the investigator. For examples, see Student-Structured Learning in Science (Matthews, Phillips, and Good, 1971, Chapter 4).

Other misconceptions have arisen because of confusion over initial publication dates. It is not uncommon for some of Piaget's early books, originally published in the 1920's, to appear in paperback with a 1960, or later, publication date. Since Piaget's emphasis, techniques, and theory have evolved over the past forty years, it is unfortunate that research effort is still being expended to "prove" these early books "wrong."

For example, The Child's Conception of Physical Causality (Piaget, 1965) was originally published in French in 1927 and was intended as no more than a description of exploratory investigations. Within the past few years, however, the Geneva group has been engaged in a detailed examination of the role of causality in intellectual development. Over 100 experiments have been performed, and these studies are in various stages of publication.

Perhaps one of the most detrimental misconceptions has been the assignment of specific age levels to the attainment of certain concepts. Some investigators believe that they have shown Piaget to be "wrong" if their results indicate an earlier or later age of attainment. (Such variations occur frequently since these investigators often utilize different scoring criteria.) Studies of this nature show nothing except the investigator's lack of understanding of Piaget. The age of attainment of certain concepts has been shown to shift among various samples, but this fact is not of prime importance. The vital point, so often missed, is that the order of attainment has been found to be constant in many replications with many different samples (Piaget, 1964).

Another age-related error is found among those investigators who seemingly expect a child to become totally concrete operational on the date of his birth or seventh birthday. Apparently some researchers have difficulty in accepting the idea that a child may function "concretely" at certain times or with certain content and that the same child may function at a different level in other situations (Uzgiris, 1964).

The concrete operational child does not exist, he is a construct. Piaget describes characteristics of the various stages of development, but these characteristics are presented as optimum capabilities; they are not observable at all times in a given child. Therefore, statements such as, "These subjects were in the concrete operational stage," are not only misleading, they are patently incorrect. A precise statement would be, "These subjects were found to be in the concrete operational stage on these tasks."

A similar difficulty with terminology arises in describing performance on conservation tasks. One often finds, "These subjects were conservers of number." Needless to say, the phrase "on this task" should be added for exactness. Some children will conserve on one part of a task, but will often not conserve when faced with a slight variation of the same task.

Still other researchers have difficulty seeing beyond semantic problems with young children. These investigators are convinced beforehand that a child's poor performance on Piaget-type tasks is caused only by language difficulties. Certainly, young children often do not understand such terms as "more, same, less," but an objective researchers would ascertain a child's

ability to interpret these terms before giving Piaget-type tasks to that child. The "language problem" exponents lose much of their persuasiveness when faced with data that show adolescents and adults performing poorly on Piaget-type tasks (Elkind, 1961; McKinnon and Renner, 1971). It is difficult to argue that adolescent and adult subjects do not know the meaning of "more, same, less."

Finally, a point of explanation is needed about Piaget's use of symbolic logic in describing certain characteristics of formal operationl thought. Some valid questions have been raised concerning Piaget's use of certain operations and symbolism (Parsons, 1960; Flavell, 1963), but the major intent should not be obscured: Piaget is <u>not</u> trying to force-fit the growth of intelligence into the intricate forms of classical logic. He uses symbolic logic as a means of describing certain mental operations in much the same way that a physicist employs mathematics to describe physical phenomena. A physicist does not restrict his descriptions of reality to the rules of pure mathematics, just as Piaget does not restrict the reality of adolescent thought to the structures of classical logic.

<u>The Neophyte's Error: Teaching the Tasks</u>

After reading several conservation tasks, many individuals who are new to the work of Piaget will attempt to teach these tasks to children. That is, they will teach (or train) the child the correct <u>words</u> to say in response to a particular task. Such behavior can be explained partially by the unique nature of the tasks, but the fundamental reason is far more subtle and not often recognized: Piaget's data, especially those from conservation tasks, pose a very real threat to the "learning = memorization" concept of intelligence.

For example, most individuals realize that the concepts investigated in Piaget-type tasks are important and fundamental. It is disturbing to these individuals to find first-grade children who can count to 100, but who cannot conserve number in Piaget's conservation-of-number task. This indicates that these children have accomplished rote memorization of a verbal sequence, but that they have little grasp of number concepts. Obviously, such omissions cannot be tolerated in a "learning = memorization model of intelligence.

To rectify such incongruities the well-meaning novice will teach children the correct responses to particular tasks. Nothing is gained, of course, except perhaps the "task teacher's" peace of mind. Shortly thereafter, one may hear, "Oh, yes, those kids can do that. They just didn't understand the task the first time."

The tasks are diagnostic instruments only. They are indicative of a particular level of intellectual development and nothing more. Training a child to repeat memorized task responses has little lasting effect upon his cognitive development (Smedslund, 1961).

The Piaget-related research literature is filled with numerous training studies. The typical approach is: (a) give tasks to the subjects, (b) train the subjects to do these tasks; and (c) give the subjects the tasks again. It is certainly no surprise when these investigators report increased proportions of subjects passing on the posttest tasks. Training of this type, coupled with improper scoring criteria, leaves little doubt as to the outcome.

Some investigators have attempted to ascertain the long-range effects of certain activities or equipment upon children's task performance. These researchers have not attempted to train children to give answers to particular tasks, but have provided experience in related and prerequisite concepts. Such research is appropriate and can make a positive contribution to the understanding of the development of human intelligence.

To some extent, at least, an individual's level of understanding of Piaget (the theory and the tasks) is inversely proportional to the desire to teach the tasks to children.

Common Research Errors: Possible Causes and Cures

Conflicting results and exaggerated claims are found in much of the Piaget-related research literature. The numerous misconceptions are nowhere better exhibited than in the large number of incorrectly performed research studies.

For most individuals, Piaget is difficult to comprehend, especially since his definitions of intelligence and intellectual development are so different from the tradiational interpretations. But there is another factor which contributes to the misuse of Piaget's work: Very few areas of educational or psychological research demand the depth of study that is required to understand what Piaget is about.

It appears that most researchers are accustomed to acquiring expertise in a given field within a few months; therefore, the idea of spending a year in careful study and in performing preliminary interviews with children is obviously not acceptable. Even the mechanical aspects of a Piaget-related study require much more preparation.

Piaget (1963, p. 8) states that approximately one year is required to train an individual in the techniques of interviewing children. Those individuals who have attempted to train research teams probably agree with Piaget, since they have witnessed many of the incorrect behaviours (cueing, leading, etc.) exhibited by beginning interviewers. Use of standardized task protocols does permit an interviewer to memorize the task procedure up to a point, but no amount of memorization will guide an interviewer when the child responds to the question of "Why do you think so?"

To deal with the large variety of subject responses, the interviewer must have a thorough knowledge of the theoretical basis of the task: What is it testing? What is relevant? What points of the child's response should be pursued? These questions, and others, can be resolved only by an interviewer who is cognizant of the underlying hypotheses of the theory.

Most of the common errors found in the research literature are directly attributable to the investigator's lack of knowledge of Piaget's theoretical basis. For example, in many studies it is quite obvious that the investigator has little or no knowledge of the concrete-operational groupings and their important role in the theory. One wonders if these investigators know which grouping, or group, that a particular task is examining. An investigator, knowledgeable in the aspects of Grouping IV (bi-univocal multiplication of classes), would not commit the errors often found in tasks dealing with multiplicative classification. Similarly, an investigator aware of the characteristics of Grouping V (addition of asymmetrical relations) would not perpitrate the errors often found in tasks concerned with seriation.

In addition, many investigators do not recognize the characteristics of, and the difference between, the logical groupings and the infralogical groupings. Nor do they realize that conservation tasks are concerned with infralogical elements while other tasks are concerned with logical elements.

The reader should note that the points considered above deal only with mental structures of Piaget's concrete-operational stage. The subsequent stage, that of formal operations, is even more demanding of the aspiring researcher. He must study Piaget's symbolic logic and become knowledgeable in the basic mental structures of formal-operations: the lattice of the sixteen binary operations, the INRC group, and the eight formal-operational schemes.

Errors abound in the studies with young children, and yet these investigations deal with some of the simpler aspects of Piaget's work. If researchers cannot comprehend the theory at this level, then what manner of misconceptions and mutilations will be fostered in the growing number of formal-operational studies? For example, one paper (Engelman, 1967) purportedly shows that preschool children (ages 3 1/2 to 4 3/4 years) can deal with a formal-operational problem in propositional logic. Piaget's terms have been used, but this investigation certainly does not test formal-operational thought. Here, again, we find an example of teaching children to "say" certain words (in this case, "if . . . then . . .") and then equating these words to an entire range of complex mental structures.

Performing proper research within Piaget's framework requires much reading, interpretation, and synthesis. An investigator who believes that

within a few months he can comprehend (or dismiss) forty-five years of work with children is being highly presumptuous. Perhaps Flavell (1963) has best stated the case:

> Piaget has done and said so much in a busy lifetime that foci for possible contention and disagreement abound. More than that, he has consistently done and said things which run so counter to accepted practice as to make for an immediate critical reaction in his reader, almost as though he had deliberately set out to provoke it. Many of the criticisms to which his writings lay him open are very obvious and require little critical acumen to find; they are the kind of critical points which attract the first-year graduate-student mentality the way a light attracts a moth. And who of us does not have residuals of this mentality?
>
> As we see it, this state of affairs has dangerous potentialities. More than most, Piaget's system is susceptible to a malignant kind of pre-mature foreclosure. You read his writings, your eye is drawn at once to its surface shortcomings, and the inclination can be very strong to proceed no further, to dwell on these (rather as the preoperational child centers but cannot decenter) to the exclusion of finding out what there may be of positive value underneath (p. 405).

Conservation Tasks

A review of the Piaget-related research literature supports the contention that certain fundamental aspects of Piaget's work are misunderstood, for example, the idea of "conservation." According to Inhelder and Piaget (1958, p. 32), conservation of an empirical factor (length, mass, number, etc.) is exhibited by a child who holds that factor invariant during observed changes of state (position, shape, etc.). The particular factor under investigation must remain constant throughout the task, or obviously, there is no conservation involved. Two authors (Mehler and Bever, 1967) report data from "conservation' tasks, but they

did not observe the basic requirement of invariance; therefore, conservation was not actually investigated. The reader should examine Piaget's reply to this paper (Piaget, 1968).

Another frequent error found in conservation task presentations is an improper treatment of the necessary "equivalence" relationship. As stated above, a conservation task tests the child's ability to hold constant an invariant factor, therefore, an equivalence relationship is always inherent in these tasks. In some conservation tasks the child must overtly establish an equivalence relationship. For example, in a typical conservation-of-number task the child is required to establish a one-to-one correspondence (equivalence) between two sets of objects.

Some conservation tasks do not necessitate an overt establishment of equivalence. For example, consider one form of a conservation-of-area task. The subject is presented with a piece of green paper or cloth (a "pasture"); then four red blocks ("barns") are placed on the "pasture." The "barns" are arranged in several different configurations on the "pasture," and with each arrangement the child is asked if the cows would have more grass to eat, less grass to eat, or the same amount of grass to eat as compared to a previous arrangement. The equivalence relationship in this task is "built-in," that is, the same piece of cloth ("pasture") and the same blocks ("barns") are used throughout.

The classic and often cited conservation-of-amount task, which uses balls of plasticene, required that the child establish an equivalence relationship. The subject should be presented with four plasticene balls

(two equal in mass, one larger, one smaller) and asked to select the two balls that have the same amount of plasticene. At this point the validity of the entire task depends upon the certainty of the equivalence relationship in the child's mind. Even though a subject may pick the "correct" two balls of plasticene, the knowledgeable investigator will pursue with, "Are you sure those have the same amount?" And if the subject exhibits the slightest doubt, then, "If you're not sure, then take some clay off one and put it on the other until you are sure."

Some researchers either ignore the equivalence relationship completely, or they establish it for the child. Telling a child, "See, these two balls of clay have the same amount of clay," is a highly suspect procedure. Did the child believe the investigator or not? One cannot be sure, especially in light of young children's susceptibility to adult suggestion.

The actual equality of the quantities involved in an equivalence relationship is of little importance. The crucial factor is that the child, in his own mind, is convinced of the equality. If there is any doubt as to the certainty of an equivalence relationship, or if the child cannot establish the relationship then the task must be terminated.

One group (Goldschmid and Bentler, 1968) has developed a set of standardized task protocols. These are well done in many respects, but in certain tasks the interviewer is instructed to say, "See, these have the same amount." In effect, the interviewer establishes equivalence for the child, and this is an improper procedure. Very little effort is required to correct these protocols.

Even though conservation tasks have certain unique characteristics, some investigators have difficulty recognizing when they are testing conservation. Additional time spent in studying the work of Piaget, especially task descriptions and the logical and infralogical groupings, would doubtless remedy this situation, but for present purposes the characteristics listed in Table 1 may serve as criteria for recognizing a conservation task.

Table 1

Characteristics of Conservation Tasks

a. There is an invariant factor (i.e., number, amount, length, weight, area, volume, etc.) which is held constant throughout the task.

b. A subject-established equivalence, when required, is established on the invariant factor. (That is, it is improper to have the subject establish equivalence on, say, area, and then question him on volume.)

c. There is an observable change of some of the task equipment, but there is no change in the invariant factor. (That is, there is a perceptual miscue such as a change in shape, size, configuration, placement, etc.)

d. The correct solution of a conservation task is obtainable only by means of logical reasoning, i.e., by arguments based upon identity and upon the two forms of reversibility (negation and reciprocity).

Replicability

Before a particular journal article can rightfully be given the label of "research paper," there are several requisite criteria which that article

must satisfy. Foremost among these requirements is that of replicability. Can the reader replicate the experiment? If replication is impossible, then the entire experiment -- including the data, results, satistical analyses, conclusions, implications, etc. -- is of questionable value.

The act of replicating an experiment to investigate reproducibility of results is a fundamental validation procedure of scientific research. Yet it appears that many investigators, especially those in the social sciences and education, either discount the importance of replication or they are unaware of its necessity.

If while reading a chemical journal one found the statement, "Some hydrochloric acid was added to the mixture," then several questions would occur immediately: When? How much? What concentration? What was the temperature of the mixture? A knowledgeable scientist would not commit such errors; he realizes that the reader must have such information before replication is possible.

Most of the Piaget-related studies reported in the literature cannot be replicated to any extent whatsoever. Scoring criteria are either vague or are omitted, task protocols are incomplete or are not included, and precise descriptions of equipment are non-existent. To repeat these experiments requires the role assignment of "replicator as mystic."

The use of a commercial, standardized instrument (e.g., an achievement test) in a research study insures some common ground between the investigator and the reader. Replication is possible -- at least within limits -- since the reader can obtain the same instrument and employ the same standardized scoring criteria. In direct contrast, the essential elements of a Piaget-

related study can only be obtained from the study itself. If an investigator does not include equipment descriptions, task protocols, and scoring criteria in his report then the reader has no source from which to obtain this information. A report of Piaget-related research should not only contain traditional data (e.g., sample selection, etc.), it must include several additional components which are unique to Piaget-related studies.

Equipment Description and Presentation

As pointed out above, research data have shown that merely changing equipment will often suffice to alter a child's responses to a particular task (Uzgiris, 1964). For example, a child may conserve liquid amount when confronted with one set of containers: the same child will often not conserve if a different-sized set of containers is used.

The manner of display or presentation of task equipment is yet another factor of concern. For example, a child who does not conserve length often believes that the length of a stick depends upon its orientation in space. Therefore, the manner in which objects are presented to the child often determines the results of an experiment.

The conservation-of-area task mentioned earlier can provide another example of equipment orientation dependence. If the "pasture" is made rectangular in shape, then the orientation of the "pasture" becomes important. (The long axis of the "pasture' may be either parallel or perpendicular to an imaginary line between subject and experimenter).

Results on this task often depend upon the orientation of the "pasture," even though the sequence of "barn" arrangements is identical. (This problem can be avoided by making the "pasture" in the shape of a square.)

A child's responses to a conservation-of-liquid-amount task often depend upon his position with respect to the containers of liquid. If the child is seated in a low chair and the containers of liquid are one or two feet distant, then his responses will often be based upon the liquid levels. If the child is seated close to and looks down upon the containers, his responses may be based upon the container diameters.

In reporting a Piaget-related research study the careful investigator will not only give complete descriptions of equipment, but will include the arrangement and orientation of all equipment. Line drawings will often help in describing equipment orientation.

Standardized Task Protocols

Most investigators involved in Piaget-related research have utilized some form of standardized task protocols, but Piaget's own work, for the most part, has not incorporated such rigid procedures. This diversity has been caused by differences in purpose: Piaget has been concerned with the broad picture of the development of intelligence while most other investigators have been concerned with the details of the theory. The transcripts of interviews, included in many of Piaget's books, are much less structured than standardized task protocols; therefore, the designation "Piaget tasks" is inappropriate in most articles. Terms such as "Piaget-

type tasks," or "Piaget-related tasks" would be more accurate and would serve to remind the reader that the investigator is utilizing procedures quite different from those of Piaget.

The omission of task protocols from Piaget-related studies prevents replication and evaluation of these investigations. What questions did the interviewer ask and in what order? Did the interviewer lead or cue the subjects by certain statements? Was the language level appropriate? In conservation tasks, was equivalence established by the interviewer or by the subject? These are only a few of the questions that go unanswered when protocols are omitted.

Some investigators state that their protocols were obtained from certain of Piaget's books, but this is impossible since the books do not contain stated protocols. Since the development of a protocol requires much synthesis from many of Piaget's transcripts, and since no two investigators would necessarily derive similar protocols, a reader cannot know what an investigator said to his subjects unless the protocol is included in the article.

Scoring Criteria

The misuse of scoring criteria in the Piaget-related research literature has caused more confusion than all other errors combined. Many of the conflicting results found in the literature are caused by nothing more than differences in scoring criteria.

Some investigators avoid these problems by ignoring scoring criteria entirely. The reader often finds extensive tables of statistical analyses

of numerical scores, but no explanation of how scores were assigned. Upon what basis were the subjects scored "pass" on a particular task? If the substages of a task were scored numerically, then what criteria were used for each substage? Page after page of statistics are of little value when the scoring criteria are not clearly stated.

In most Piaget-type tasks the child is required to choose between two or more possibilities and then to state reasons for his particular choice. An investigator who does not ask for reasons or who scores the child "pass" upon choice alone is not engaged in Piaget-related research. Obviously, in choice-only scoring procedures the child has a good chance to guess the correct response, but this is unimportant. The omission of reasons in the scoring criteria usually indicates that the investigator has little grasp of the fundamentals of Piaget's theoretical bases. To explore the child's thinking, especially the logic underlying a particular choice, is the primary reason for presenting the task. Choices alone provide no information as to the child's level of ability to utilize logic in his thinking processes.

In certain circumstances an investigator may desire or be required to score on choice-only data. In such an event these data should be clearly and emphatically marked so that the reader will be aware of the difference. Obviously, such data should not and can not be compared to those of Piaget.

Attention is now called to those researchers who include reasons in their scoring criteria. These individuals recognize the importance of scoring the subjects' reasons, and they are to be commended, but the quality of the reasons accepted is often questionable. Subjects are often scored

"pass" on a particular task for reasons which are incorrect, incomplete, or insufficient. In fact, some investigators score a child "pass" if the child utters any collection of words -- logic is not considered. The selection of particular reason-scoring criteria indicates the investigator's comprehension, or lack of comprehension, of Piaget's theory of intellectual development.

In the scoring of subjects' responses to conservation tasks, reasons should be scored in terms of three major criteria: (a) identity; (b) negation; and (c) reciprocity. (The latter two criteria -- negation and reciprocity -- are both forms of reversibility, but they should be treated separately in research reports.) Furthermore, the investigator should make clear his use of these three criteria. Were his subjects required to give evidence of one, two, or all three before the score of "pass" was assigned? Two books, at least, have described these criteria in detail (See Ginsberg and Opper, 1969, pp. 151-2; or Matthews et. al., 1971, pp. 4-16 and 4-17).

Insufficient reasons may be categorized in several ways, but this author has found that three categories usually suffice: (a) descriptive reasons, (b) action reasons, and (c) reasons that only repeat a choice. For example, consider the conservation-of-area task described above. Assume that the barns have been moved to new positions on the "pasture" and that the subject has said that the cows would have the same" amount of grass to eat. The experimenter then asks, "Why do you think so?" The subject may then respond with a correct reason (based upon identity or reversibility), or he may reply with incorrect reasons similar to those below:

Insufficient Reason	Category
"The barns are still on the pasture."	Description - subject only describes the situation
"You moved the barns."	Action - subject only describes the actions of interviewer or equipment
"The amount of grass would still be the same."	Repeat of choice - subject reiterates the choice in expanded form.

A subject may well be able to conserve area on this task, but the above reasons alone are not sufficient for assigning a score of "conserver" to a subject. Such responses must be pursued by a perceptive interviewer. One procedure for the pursuit of descriptive and action responses is for the interviewer to agree with the subject: "Yes, the barns are still on the pasture (or, I moved the barns) and you told me the cows would have the same amount of grass to eat. Why do you think so?"

For reasons which are a repeat of the choice, the interviewer can pursue with, "You think the cows would still have the same amount of grass to eat. Now tell me why you think this." In any event the "Why?" question should be asked again, but without cueing the child that he has given an insufficient response. If a subject is unable to supply reasons other than descriptive, action, or choice repeats, then he cannot be scored as a conserver of area on this task.

Certain Piaget-type tasks contain their own unique type of insufficient reasons. For example, in a conservation-of-number task subjects will often follow a choice of "same" with the reason, Because I counted them. This

response alone is insufficient for scoring a subject as a conserver of number on this task. The point of interest is not the counting ability of the child, but whether or not he can logically maintain the invariance of number regardless of perceptual miscues. A true conserver of number on this task has no need to count and, indeed, he will not count if the objects used in the task have been obserable at all times. A child who states a reason based on counting may or may not be a conserver of number on a particular task, but an interviewer must pursue the response before the child can be scored. One technique is to ask the child "Can you think of another reason why they are the same?"

Many Piaget-type tasks deal with concepts other than conservation. Classification, seriation, perspective, and water-level representation are only a few of the many other areas of interest in the concrete-operational stage. Add to these the large number of formal-operational tasks which are not concerned with conservation and one is faced with a large and complex (and discouraging) array of diverse scoring criteria. These tasks, just as conservation tasks, must be scored by using choices and reasons, but additional similarities are few. An investigator must derive scoring criteria for each particular task from the theoretical basis of that task.

Statistical Analyses

Since parametric statistics require an equal-interval scale of measurement, the use of parametric statistics with data from Piaget-type tasks is often an incorrect procedure. At best, data from Piaget-type

tasks are based upon an ordinal scale, often such data are no more than nominal. Non-parametric statistics are appropriate for analyzing these data since an equal-interval scale is not required (Siegel, 1956).

Statistical tests of research data are important, but lack of common sense in their use is often observed. For example, some investigators incorrectly assign a total score to a subject which is the sum of that subject's scores on several individual tasks. Even a slight knowledge of the theoretical bases of the tasks should prohibit this procedure. It makes little sense to assign total scores for performance on a group of Piaget-type tasks since each task is investigating a unique concept.

For additional information on statistical techniques the reader is referred to Measurement and Piaget (Green, Ford, and Flamer, 1971).

Evaluation of Piaget-related Research

To summarize the points noted above, Table 2 is a list of some of the major criteria that should be considered when evaluating a Piaget-related research study. The final item in the table (i.e., interview technique) cannot be objectively evaluated, of course, unless the reader has access to some record of the actual interviews (e.g., tape recordings). However, the reader may often obtain some clues (even though subjective) from the investigator's overall approach to the study. For example, if an investigator used proper task protocols, described equipment, employed correct scoring criteria, and stated a proper theoretical basis for his study, then the reader would be inclined to attribute correct interview techniques to that investigator.

Table 2

Criteria for Evaluating Piaget-Related Research Studies

1. Can the study be replicated?
2. Are task protocols included and are they correct?
3. Is equipment and its method of presentation described?
4. Are complete scoring criteria included?
5. Are choices and reasons scored, and if so, are acceptable reasons based upon the underlying logical models of the tasks?
6. Does the theoretical discussion include more than superficial statements?
7. Are conclusions derived from the proper use of statistical analyses of ordinal data?
8. Are conclusions compared to other research studies, and if so, are the comparisons valid?
9. Did the investigator use proper individual interview techniques without leading or cueing the subjects?

If the evaluation criteria presented in Table 2 can be answered "yes" for a particular research study, then that study can be classified as one of merit. The perceptive reader will find, however, that many Piaget-related studies cannot be scored "yes" on even one of these criteria.

Extension

Superficial knowledge of Piaget will prompt some readers to dismiss this critique as an elaboration of irrelevant details, but those individuals

who have studied the work of Piaget are aware of the misconceptions caused by imprecise research. For example, in discussing Piaget, some college textbooks make statements to the effect that training accelerates the acquisition of certain Piaget-related concepts (e.g., conservation). The textbook author often cites a research paper as the basis for these statements, and students learn (i.e., memorize) that "training has an effect." Frequently, the "research" paper cited in the textbook is of poor quality; conclusions were based upon improper scoring criteria, etc., but the damage is done; the error is propagated.

The issue of whether Piaget is "wrong" or "right" has no meaning at this point in time. Perpetrators of such arguments only exhibit their own scientific immaturity, especially their misunderstanding of the role of a theory or model. This naiveté is apparent throughout the research literature.

Theories and models are "made up" by scientists to aid in the explanation of various phenomena. Some of these inventions endure for many years in their original form, others undergo revision or qualification, while others are discounted within a short time. But all make a contribution. Even those theories or models of seemingly little merit have served often as necessary precursors of more precise theoretical formulations.

To approach Piaget's contribution in terms of its "wrongness" or "rightness" is akin to asking someone whether or not he "believes" in the theory of evolution. An individual of scientific expertise will not even enter this frey; he is aware that belief or non-belief is incon-

sequential. A theory or model exists to be tested, expanded, corrected, or, perhaps, discarded entirely. Clarity is only hindered by those whose goal is to prove or disprove a theory in a single, biased, often unprepared research study.

Piaget has derived (and is still deriving) a model of intellectual development. His work has spanned many years and yet he has explored only a small segment of human cognition. His particular avenue of approach, through the growth of logical thinking, may or may not prove to be viable in the years to come, but such decisions will likely not be made for several generations. Productive contributions to this exploration will be made only by those careful researchers who accept Piaget's contribution within its proper context -- it is a beginning.

References

Elkind, David, "Quantity Conceptions in Junior and Senior High School Students". Child Development, 1961, 32, 551-560.

Engelman, S., "Teaching Formal Operations to Preschool and Disadvantaged Children". Ontario Journal of Educational Research, 1967, 9, 193-207.

Flavell, John H., The Developmental Psychology of Jean Piaget. Princeton, New Jersey: D. Van Nostrand, 1963.

Ginsburg, Herbert and Opper, Sylvia, Piaget's Theory of Intellectual Development: An Introduction. Englewood Cliffs, New Jersey: Prentice-Hall, 1969.

Goldschmid, Marcel L. and Bentler, Peter M., Concept Assessment Kit--Conservation. San Diego: Educational and Industrial Testing Service, 1968.

Green, Donald R., Ford, Marguerite P., and Flamer, George B. (Eds.) Measurement and Piaget. New York: McGraw-Hill, 1971.

Inhelder, Barbel and Piaget, Jean, The Growth of Logical Thinking. New York: Basic Books, 1958.

Matthews, Charles, Phillips, Darrell, and Good, Ronald, Student-Structured Learning in Science. Dubuque: W. C. Brown, 1971.

Mehler, Jacques and Bever, Thomas G., "Cognitive Capacity of very young Children". Science, 1967, 158. 141-142.

McKinnon, Joe W. and Renner, John W., "Are Colleges Concerned with Intellectual Development"? American Journal of Physics, 1971, 59, 1047-1052.

Parsons, Charles, "Inhelder and Piaget's The Growth of Logical Thinking". British Journal of Psychology, 1960, 51 (1), 75-84.

Piaget, Jean, The Child's Conception of the World. Patterson, New Jersey: Littlefield, Adams, 1963.

Piaget, Jean, "Development and Learning". Journal of Research in Science Teaching, 1964, 2, 176-186.

Piaget, Jean, The Child's Conception of Physical Causality. Totowa, New Jersey: Littlefield, Adams, 1965.

Piaget, Jean, "Quantification, Conservation, and Nativism". Science, 1968, 162, 976-979.

References Continued

Siegel, Sidney, Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill, 1956.

Smedslund, Jan, "The Acquisition of Conservation of Substance and Weight in Children III". Scandinavian Journal of Psychology, 1961, 2, 85-87.

Uzgiris, Ina C., "Situational Generality of Conservation". Child Development, 1964, 35, 831-841.